I. C. 6799 OCTOBER 1934

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MINING METHODS AND COSTS

AT HERRON AND LASTER LEASE, SUPERIOR, ARIZ.

BY

E. D. GARDNER

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MINING METHODS AND COSTS AT HERRON AND LASTER LEASE, SUPERIOR, ARIZ.[1]

By E. D. Gardner[2]

INTRODUCTION

About 300 tons of gold ore per week was being produced in February 1934 by Thomas D. Herron and Con Laster from the old Lake Superior and Arizona workings; the ground was leased from the Magma Copper Co. The workings adjoined but were not a part of the Magma mine. The lessees had been employees of the Magma Copper Co. at the time the Magma closed down for the summer of 1932. Work on the lease began in July 1932 on an exposure of $2-per-ton ore disclosed in a drift; after a few hand-drilled rounds were blasted the gold content increased to about $30 per ton. Extensive sampling by pannings elsewhere of exposed portions of the vein indicated that other ore shoots existed. The last work previously done in the mine was during the World War, when lessees mined a number of small shoots of copper ore. In some of the stopes the copper miners had left a quartzose streak on the hanging wall that carried $15 per ton of gold. This material did not look as if it carried values and evidently never had been sampled.

The first shipment of gold ore was made on September 28, 1932. Up to April 1, 1933, 3,778 tons had been shipped and from September 1, 1933, to January 31, 1934, 3,125 tons.

The smelter was shut down from July 1 to December 31, 1933. Shipments ceased during this period, except some ore taken after September 1 for bedding at the smelter. About 800 tons of ore was stock-piled. No compressed air was available from July 1 to September 1; all drilling during this period was by hand.

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1 - The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from U. S. Bureau of Mines Information Circular 6799."

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GEOLOGY

The ore occurred in a vein along the bedding plane between limestone and quartzite; the limestone overlaid the quartzite. The dip of the beds was about 28°. The ore occurred where fractures or "breaks" cut through the beds. In the ore zones the vein material usually consisted of a streak of quartz or quartzose material on both hanging-and foot-walls, separated by 1 to 3 feet of iron oxide. In places copper was associated with the iron. Some of the iron oxide was gold-bearing. The gold-bearing quartz was contained in the hanging-wall streak, except in one case where the foot-wall quartz was ore. The quartz ore was high enough in silica so that it could be used as a converter lining. The quartz and iron ores were mined and shipped separately.

The ore shoots were small, averaging about 15 feet on the strike and 25 feet on the dip. The average thickness of the vein where ore-bearing was about 4 feet. In other places it consisted only of a contact seam. The limestone hanging wall stood well. The ore was easier to break where it was wide than where it was narrow. Besides being "bunchy", the ore bodies were cut by minor faults. The occurrence of the gold in the ore was also erratic, as was illustrated on the seventh level, where the ore exposed in the old workings as sampled indicated a value of $1.60 per ton; the first round assayed $0.80 and the next $20.00.

Panning was used extensively for determining ore limits. The results obtained by panning were checked by frequent assays. All samples showing an appreciable amount of gold were assayed.

DEVELOPMENT

The mine workings at the time the lease was taken consisted of a 1,400-foot inclined shaft on the contact between the limestone and quartzite and 8 levels from the shaft. The vein was fully developed by levels and raises. One level, the second, was a drift on the contact from the surface at the level of Queen Creek. Most of the ore mined by the lessees was trammed to ore bins at the portal of the adit. Ore below the second level and tributary to the main incline was hoisted to the first level and thence trammed through a crosscut to an ore bin at the surface.

In April 1933 the lessees were working above water level on 3 of the upper 5 levels. About 10 faces were being worked concurrently, but drilling was done in only 3 to 5 places at once. In February 1934 work was being done on the upper 7 levels. The 7th level, however, was not connected to the shaft. Preparations were also being made at this time to mine on the 8th level, the lowest in the mine.

Development work by the lessees has consisted mostly of raising in the search for ore and the attempt to reach known ore bodies. Up to April 1933 three winzes--125, 40, and 25 feet, respectively--had been sunk; since then several more have been run. Up to February 1934 the lessees had done 125 feet of drifting.

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STOPING

An open-stope method was used; the ground stood well, and only an occasional stull was required to support the back. As the stopes were small, no extended areas needed to be held up. In many instances the stopes were not larger in section than raises.

In stoping, the iron stratum, which was softer than the quartz, was broken first and if gold-bearing was taken from the mine; the overlying siliceous ore was then drilled and blasted. In narrow ore bodies, however, the two classes of ore was broken together.

In the old copper stopes, stoping consisted only of shooting down and removing the quartz stratum left at the hanging wall.

Ore was mined both from raises and winzes. If above the level, it was worked down the slope by shovels to chutes built at the level, whence it was drawn in cars.

In underhand stoping the ore was shoveled into 1/2-ton skips and hoisted to chutes at the level. If under 14 feet wide the ore would be mined as the winze was deepened. If over 14 feet the winze would first be sunk to the bottom of the shoot or a raise put up from the level below for mining it. Stoping would then be done upward.

In February 1934 very little stripping was being done. Ore down to 18 inches in thickness was mined without stripping. Both drilling and shoveling in these narrow stopes were done by the men while lying down.

Narrow ore bodies below the level up to 14 feet in length on the strike were mined by sinking a winze in the middle of the shoot. Enough of the footwall was cut out to give room for a track and to provide headroom for the skip. The ore on either side of the winze was then broken by down holes and shoveled into the skip. Stoping kept abreast of sinking.

Care was taken to break the ore clean and to get all of it. Up to April 1933 the ore from various parts of the mine was mixed to a shipping product of about $18 per ton. Little sorting was done underground; however, if the ore was less than 18 inches thick, enough waste was broken to provide this minimum working width. In this instance the quartz which contained the gold would be sorted out, or if the quantity of waste was less than the ore the waste would be removed.

About 2 tons of ore was broken to each ton of development waste. On an average, three drills were working on ore to one on waste. Most of the waste was trammed to the surface and dumped. When convenient it was used for back-filling, but ordinarily it was cheaper to take it from the mine; moreover, the stopes stood well without filling.

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The average ore was fairly easy to drill; rounds were drilled mostly with mounted jackhammers or leyners. In the softest ground, handheld jackhammers were used; sometimes stopers were employed in hard ground. In narrow shoots, stopers or jackhammers were used.

Bargain lots of steel had been purchased at various times. For jackhammers 7/8-inch octagon and 1-inch round steel were used, 1-inch square for stopers and 1 1/8-inch round for leyners. All steel for jackhammers and leyners had the same shank. In February 1934 a 11,500-pound stock of steel was on hand.

Gelatin dynamite of 35- and 40-percent strength was used for blasting. About 1.8 pounds of powder was used per ton of ore, including development work. The 35-percent explosive cost 13.5 cents and the 40-percent 14 cents per pound in April 1933.

Most of the ore shoots were too small in cross-section to justify the use of scrapers. Moreover, where justified the lessees preferred to use hand labor to give more employment.

HAULAGE

The ore was hoisted from below the second level through the main shaft and from winzes. A 15-hp. electric hoist and a 1/2-ton skip were used in the main shaft and small air tuggers and 1/4-ton skips at the winzes. Most of the ore reached the surface through the adit on the second level. Tramming was done by hand in 16-cubic foot cars on an 18-inch-gage track with 16-pound rails. Between 35 and 45, and an average of 40, cars were trammed 2,500 feet per trammer-shift. All of the cars had brakes. The trammers rode the loads out and pushed the empty cars back. The hoistmen loaded the cars.

The tracks were in the mine when the lease was taken; however, they were in bad condition, and at the start of operations only 9 or 10 cars could be trammed per man-shift. The lessees spent about $1,400 in relocating, realigning, and ballasting the tracks, with the improved results mentioned above.

An ore bin already on the ground at the first level held 50 tons. A bin with two 65-ton compartments was built by the lessees at the portal of the adit. It was erected on a side hill by constructing walls of vertical 8- by 8-inch posts lagged on the inside with 2-inch timber and held together at the top by hoisting cable. The bottom consisted of well-packed fine waste at an angle just under the angle of repose of the ore. The ore was loaded out through wooden gates into trucks. The cost of the ore bin was included in the general labor and supply items. Second-hand timber was used.

During the summer of 1933 a third ore bin holding 60 tons was built.

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The ore was trucked under contract (75 cents per ton) about a mile, where it was loaded into railroad cars. The contract price included loading the trucks and maintaining the road.

A switching charge of $7.32 per car was made for handling the car from the loading point to the smelter.

EQUIPMENT

The mine was equipped with tracks and air lines. The lessees put in water lines in the mine and a supply line for both air and water to the Magma workings about 1/2 mile distant.

Nearly all mining equipment had been bought secondhand. The following table shows part of the equipment purchased with the price paid up to April 1933. The rest of the equipment purchased up to this time was included in general expense.

Mine equipment

Item	Cost
1 hoist, Ingersoll Rand, large tugger	$ 80.00
1 hoist, Ingersoll Rand, little tugger	50.00
1 hoist, Ingersoll Rand, little tugger, with 2 drilling bars and arms, 3,000 pounds leyner steel, and blacksmith tools	52.50
1 stoper (new)	230.00
3 jackhammers with 71 pieces of steel and 5,000 board-feet of timber	300.00
2 16-cubic foot mine cars with 500 feet 2-inch pipe, 300 feet 1-inch pipe, and miscellaneous tools	200.00
1 jackhammer	80.00
1 truck, 1 1/2-ton	338.00
(Other equipment, including 1 leyner drill; 1 jackhammer; 1 model 8 Waugh drill sharpener; 2, 16-cubic foot and 2, 12-cubic foot mine cars, charged as general expense)	
Total	$ 1,308.50

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Between April 1933 and February 1934 the following additional equipment was purchased:

	Item	Cost
1	15-hp. electric hoist	$ 500.00
1	tugger (Turbinair)	50.00
4	16-cubic foot cars, each $10.00	40.00
5	N-72 leyner drills (rebuilt), at $90.00	450.00
30	jackhammers (old), at $35.00	1,050.00
15	stopers (old), at $35.00	525.00
3	tons of drill steel, 5 cents per pound	300.00
1	ton of drill parts, lot	50.00
	Total	$ 2,965.00

The old drills were reconditioned by the lessees' blacksmith. The wheels of the cars were reground, and bronze bushings and alemite plugs were installed at a cost of $10 for each car. Used office equipment, consisting of a typewriter, adding machine, calculating machine, and check protector, was purchased for about $125.

The office supplies and nearly all of the mining equipment mentioned immediately above were bought from a mining company at Globe that was selling its equipment.

The surface buildings were a 16- by 16-foot blacksmith shop and an 8- by 20-foot change room, both built of used corrugated iron and secondhand lumber. The labor and supplies were included in the general items. An office was fitted up in an old store building in the spring of 1934.

Compressed air and water were furnished by the company. Compensation for these services was included in the royalty charged the lessees; no direct charge was made.

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LABOR

On April 21, 1933, the average labor employed was as follows:

Number	Classification	Per day	Total
12	Miners	$ 4.50	$ 54.00
1	Trammer	5.00	5.00
2	Trammers	3.52	7.04
1	Timberman	4.50	4.50
1	Hoistman	5.50	5.50
1	Blacksmith and mechanic	5.50	5.50
1	General utility man	5.00	5.00
19	Total daily		$ 86.54

In February 1934 about 40 men were being employed. Of this force the following were considered temporary employees: 4 shaft men repairing shaft and installing bells; 2 men repairing ore bins and ore pass; 2 men installing hoist at a new winze; 2 men running crosscut to shaft to connect with surface; 1 electrician; and 1 surface man.

No shift bosses were employed. All supervision was done by the lessees. The bookkeeper ran a jackhammer underground and did the office work after coming out of the mine. A bonus was paid the men, based upon the grade of ore and tonnage mined. Contracts (with day's wages guaranteed) also were given for mining individual stopes.

During the 1933 summer shut-down of the Magma mine, 12 to 22 men were employed by the lessees. They were paid $1 per day in cash and given orders on the local stores for the remainder of their wages. The local merchants were willing to wait until shipments were resumed for payment.

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MINING COSTS

The stoping cost per ton in a representative stope in January 1934 was as follows:

21 winze stope (ore 4 feet thick, 30 feet on strike; 259 tons produced)

Labor:		
Miners and trammers	$ 1.52	
Muckers	.54	
Hoistmen	.21	
Miscellaneous	.24	$ 2.31
Supplies:		
Explosives	.43	
Timber	.12	.55
Total stoping	.....	$ 2.86

The total costs from the beginning of operations in July 1932 to April 1, 1933, during which time 3,778 tons (wet weight) of ore was shipped, are as follows:

Labor:			
Wages (including $1,200 drawn as wages by lessees)	$13,350.60		
Bonus to labor	2,237.42		
Accident insurance	628.29		
Total labor		$16,216.31	
Supervision (no other overhead)		1,600.00	
General expense, supplies and miscellaneous, excluding compressed air, but including some equipment		3,571.17	
Operating mining cost			$21,387.48
Equipment		1,308.50	
Total mining cost			22,695.98
Trucking (3,778 tons at $0.75)		2,833.25	
Total mine expense			25,529.23

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The cost per ton of producing the ore was as follows:

Labor	$4.30		
Supervision	.42		
Supplies	.95		
Total operating mining cost		1/$5.66	
Equipment		.35	
Trucking		.75	
Total cost per ton to date			$6.76

1/ Includes development and surface expense but excludes compressed air.

From September 1 to January 31, 1934, 3,125 dry tons of ore was produced. The cost per ton, including development, was as follows:

Labor	$4.07
Labor bonus	.59
Powder	.38
Timber	.27
Steel, pipe, fuse, caps, office repair, office expense, taxes, insurance, and all other charges	1/ 1.41
Total	2/$6.72

1/ Excludes compressed air.
2/ Includes $0.80 per ton haulage charge.

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